REMARKS

Claims 1-20 are pending in the application. No claims are amended herein.

Applicants thank the Examiner for his careful consideration of the present application.

For the reasons set forth below, Applicants respectfully request reconsideration of the application, withdrawal of the asserted rejections of Applicants' claims, and allowance of all presently pending claims.

Claims 1-3, 6-10, 12, 14, 15 and 18-20 Are Not Anticipated by Yang et al. and Claims 4, 5, 11, 13, 16 and 17 Would Not Have Been Obvious over Yang et al.

Claims 1-3, 6-10, 12, 14, 15 and 18-20 stand rejected as anticipated by Yang et al. and claims 4, 5, 11, 13, 16 and 17 stand rejected as obvious thereover.

Applicants respectfully traverse these rejections for at least the following reasons. Applicants respectfully request the Examiner to withdraw the rejection of the claims over Yang et al. Yang et al. neither discloses nor suggests all the limitations of Applicants' claimed invention, therefore Yang et al. can neither anticipate nor render obvious Applicants' invention.

Applicants' claimed invention, as defined and described by the pending claims, does not depend on the absolute concentration of N or O, but instead specifies that a limited amount of N is added, and that the amount of N added to the specified region does not exceed the amount of oxygen in that region. Thus, sufficient N is added at the interface to address the problems such as charge loss, dielectric reliability and hot carrier injection induced stress at the interface between a substrate and an overlying oxide layer due to the presence of either or both of silicon-hydrogen bonds which can be converted to dangling silicon bonds, and dangling silicon bonds, *per se* (see, e.g., p. 4, lines 22-25). In order to retain the desired properties of the oxide layer and to avoid converting the layer to a silicon nitride layer, the present invention limits the amount of N added to the region to approximately that amount needed to convert extant Si-H bonds and dangling silicon bonds to Si-N bonds, but with the proviso that the nitrogen concentration does not exceed the oxygen concentration in the region.

The Examiner contends that Yang anticipates the claimed process of fabricating and the device of a multi-bit charge trapping dielectric flash memory device, comprising the elements of Applicants' claims. In the Office Action, the Examiner contends:

> Yang anticipates a process of fabricating and the device of a multi-bit charge trapping dielectric flash memory device, comprising:
> in fig. 3A providing a semiconductor substrate 110;
> in fig. 3B, forming on the semiconductor substrate a bottom oxide layer 120 and a substrate/oxide interface, wherein the bottom oxide layer comprises a material having a general formula SixOyNz1 wherein x, y and z1 are atomic percentages, 121, and graph of fig. 4A; and
> in fig. 3B, adding a quantity of nitrogen to the bottom oxide layer, whereby the bottom oxide layer comprises a film region adjacent the charge storage layer and a second region adjacent the substrate/oxide interface, whereby the second region comprises a material having a general formula SixOyNz2, wherein x, y and z2 are atomic percentages, and y>z2>z1, col. 2, lines 49-55, col. 3, lines 16-30;
> in fig. 3B, wherein the bottom oxide layer comprises a first oxygen concentration and a first nitrogen concentration; and adding a quantity of nitrogen to the bottom oxide layer, whereby the bottom oxide layer comprises a first region adjacent the charge storage layer and a second region adjacent the substrate/oxide interface, the second region having a second oxygen concentration and a second nitrogen concentration, wherein the second nitrogen concentration exceeds the first nitrogen concentration, ***provided that the second nitrogen concentration does not exceed the second oxygen concentration***, col. 2, lines 49-55, col. 3, lines 16-30. (Emphasis added.)

Applicants respectfully submit that the Examiner's statement of the disclosure of Yang et al. is clearly erroneous. Yang et al. in fact does not disclose or suggest the emphasized portion of the claim language repeated in the Examiner's statement of the rejection, i.e., Yang et al. does not disclose or suggest the proviso that the second nitrogen concentration does not exceed the second oxygen concentration. If fact, as shown below, Yang et al. explicitly and clearly teaches the opposite, i.e., that the second nitrogen concentration *does* exceed the second oxygen concentration in the second region.

The disclosure of Yang et al. cited by the Examiner, col. 2, lines 49-55 and col. 3, lines 16-30 neither discloses nor suggests that *the second nitrogen concentration does not exceed the second oxygen concentration in the region adjacent the substrate/oxide interface*. To the contrary, Yang et al. discloses that the nitrogen concentration exceeds the oxygen concentration in the region, following the implantation of nitrogen. This fact is best shown by reference to Figs. 4A and 4B of Yang et al. both of which show that the nitrogen concentration exceeds the oxygen concentration in the region adjacent the substrate/oxide (i.e., Si/SiO_2) interface, after the nitrogen is implanted in that region. See, Yang et al., col. 2, line 56 to col. 3, line 11. As described therein, the curves in Figs. 4A and 4B plot the concentrations of Si, N and O, in atoms/cc, on the Y (vertical) axis, against the depth in the semiconductor structure on the X (horizontal) axis. As disclosed, Fig. 4A represents a N implantation under "normal" (i.e., conventional) implantation energy level, and Fig. 4B represents N implantation in accordance with the invention disclosed by Yang et al., that is, under low implantation energy level. As disclosed by Yang et al., the cross-over point between the Si curve and the O curve is "representative" of the position of the Si/SiO_2 interface, col. 3, lines 3-5, with the SiO_2 on the left (higher O content) and the Si on the right (lower O content). The semiconductor structure, i.e., the SiO_2 (or bottom oxide) layer illustrated in both Fig. 4A and Fig. 4B, has a first region (from about zero depth to the N/O crossover at about 40Å) that would be adjacent the charge storage layer (which, when applied, would be further to the left in Figs. 4A and 4B) and a second region (from about the N/O crossover to about the Si/O crossover at about 50-55Å) adjacent the substrate/oxide (i.e., the Si/SiO_2) interface, wherein the nitrogen concentration in the second region (i.e., the second nitrogen concentration) exceeds the nitrogen concentration in the first region (i.e., the second nitrogen concentration). Up to this point, the structure of Yang et al. is similar to that of the presently claimed invention. However, as clearly shown in Figs. 4A and 4B of Yang et al., contrary to the presently claimed invention, the nitrogen concentration in the second region *exceeds* the oxygen concentration in the second region. This is exactly the opposite of the claimed invention.

This fact is proven by the concentrations of N and O shown in Figs. 4A and 4B of Yang et al. In the region of Fig. 4A from about 40Å below the surface to the Si/SiO_2 crossover point, the N content of the layer ranges from equal to the O content at 40Å (both about 3E+20) to a N content about an order of magnitude greater than the O content at the Si/SiO_2 crossover point (N ≈ 1.5E+21, O ≈ 1.8E+20). Similarly, in the region of Fig. 4B from about 30Å below the surface to the Si/SiO_2 crossover point, the N content of the layer ranges from equal to the O content at about 30Å (both about 1.3E+20) to a N content slightly less than an order of magnitude greater than the O content at the Si/SiO_2 crossover point (N ≈ 1E+21, O ≈ 1.5E+20). Thus, throughout this region (which corresponds to the claimed second region), the concentration of N greatly exceeds the concentration of O.

The foregoing points distinguishing Yang et al. based on N and O content in the second region apply with equal force to independent claims 8 and 15. In both of those claims, the bottom oxide layer is described and defined as containing a material having a general formula $Si_xO_yN_{z1}$, wherein x, y and z1 are atomic percentages, and after adding nitrogen to the bottom oxide layer, the bottom oxide layer comprises a first region and a second region adjacent the substrate/oxide interface, and the second region comprises a material having a general formula $Si_xO_yN_{z2}$, wherein x, y and z2 are atomic percentages, and $y > z2 > z1$. That is, the nitrogen content z2 of the second region does not exceed the oxygen content y thereof; to the contrary, the O content y always exceeds the N content z2, in the second region.

As shown by the foregoing, Applicants respectfully submit that the rejection of Applicants claims as anticipated by Yang et al. is clearly erroneous.

Furthermore, the anticipation rejection is legally incorrect.

In order to state a *prima facie* case of anticipation, the Examiner must show all the claimed elements in the single reference. *In re Wilder*, 429 F.2d 447 166 USPQ 545, 548 (CCPA 1970). Regarding all of the presently pending claims, the Examiner failed to state such a *prima facie* case, since the cited reference fails to disclose the proviso that the second nitrogen concentration does not exceed the second oxygen concentration in the region of Yang et al. corresponding to Applicants' second region.

An anticipating reference must describe the patented subject matter with sufficient clarity and detail to establish that the subject matter existed in the prior art and that such existence would be recognized by persons of ordinary skill in the field of the invention. See *In re Spada*, 911 F.2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990). Here, the claimed subject matter clearly did not exist in the prior art as described in Yang et al. Accordingly, there can be no anticipation of Applicants' claimed invention by Yang et al.

The Examiner is respectfully requested to withdraw the rejection of Applicants' claims 1-3, 6-10, 12, 14, 15 and 18-20 as anticipated by Yang et al.

Furthermore, Applicants respectfully submit that the presently claimed invention, as described and defined in claims 1-20 would not have been obvious over Yang et al., since Yang et al. clearly teach exactly the opposite of Applicants' proviso that the second nitrogen concentration does not exceed the second oxygen concentration. This is not and would not be considered to be a mere matter of optimization. In order to reach Applicants' invention from Yang et al., one has to do exactly the opposite of what is taught by Yang et al. There is no motivation and no suggestion, and there can be no reasonable expectation of success in so doing, that could be found in Yang et al. or elsewhere in the prior art, that could have lead a person of ordinary skill in the art to proceed exactly to the opposite of the teachings of Yang et al. Accordingly, the invention described and defined by claims 1-3, 6-10, 12, 14, 15 and 18-20 would not have been obvious over Yang et al.

Similarly, the invention described and defined by claims 4, 5, 11, 13, 16 and 17 would not have been obvious over Yang et al. Since, as shown above, Yang et al. fails to disclose or suggest the invention defined by the independent claims 1, 8 and 15, the claims dependent thereon cannot have been rendered obvious over this reference, since the reference fails to teach all of the limitations of these claims.

As noted above, Applicants' claimed invention, which is further specified by these claims, does not depend on the absolute concentration of N or O, but instead specifies that sufficient N is added at the interface to address the problems such as charge loss, dielectric reliability and hot carrier injection induced stress at the interface between a substrate and an overlying oxide layer due to the presence of either or both of silicon-hydrogen bonds which can be converted to dangling silicon bonds, and dangling silicon bonds, *per se*. In order to retain the desired properties of the oxide layer and to avoid converting the layer to a silicon nitride layer, the present invention limits the amount of N added to that needed to convert Si-H bonds and dangling silicon bonds to Si-N bonds.

This point is further supported by a consideration of the stoichiometry of the materials disclosed by Yang et al. SiO_2 contains two oxygen atoms for every silicon atom. i.e. a ratio of 2/1. Si_3N_4, silicon nitride, contains four nitrogen atoms for every silicon atom, i.e., a ratio of 4/3 or 1.33/1. Thus, in order to attain the N content as much greater than the O content as that disclosed by Yang et al., a large amount of N must be implanted into the oxide layer. This would be understood by any person of ordinary skill based on the clear and straightforward teachings of Yang et al. Such understanding leads away from, not toward, Applicants' invention.

Thus, Applicants respectfully submit that the invention defined by claims 4, 5, 11, 13, 16 and 17 would not have been obvious over Yang et al. for these additional reasons. Accordingly, Applicants respectfully request withdrawal of the rejections of all of the presently pending claims.

CONCLUSION

For the foregoing reasons, Applicants respectfully submit that all of the presently pending claims patentably distinguish over the prior art generally, and over Yang et al. in particular, and that all of Applicants' claims are therefore in condition for allowance. Applicants request the Examiner to so indicate.

If the Examiner considers that a telephone interview would be helpful to facilitate favorable prosecution of this application, the Examiner is invited to telephone the undersigned at the Examiner's convenience.

No additional claims fees are believed due for the filing of this paper. However, if a fee is required, please charge the fee to Deposit Account No. 18-0988, Order No. AF01191.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, LLP

DATE: October 6, 2004

Thomas W Adams

Thomas W. Adams, Reg. No. 35,047

1621 Euclid Avenue
Nineteenth Floor
Cleveland, Ohio 44115
Ph: (216) 621-1113
Fax: (216)621-6165

B:\Adams-Tom\Client Files\AMD\PAF1191\amdAF1191.ROA1.wpd